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(54) Bullet proof pan and tilt camera housing

(57) A swivel and tilt mounting arrangement which utilizes an oversized tubular support shaft which enables the flexible cable 108 of a TV 100, mounted on a bearing assembly 28, 30, to be threaded internally through the mounting to a fixed exit point 146. Such a mounting is used with television surveillance cameras or other equipment which must be directionally adjustable and which must be protected from extreme external forces, including gunfire. This arrangement may use worm gearing (not shown) and axially adjustable set screws (not shown) to also eliminate rotational and axial backlash in the swivel and tilt mounting.

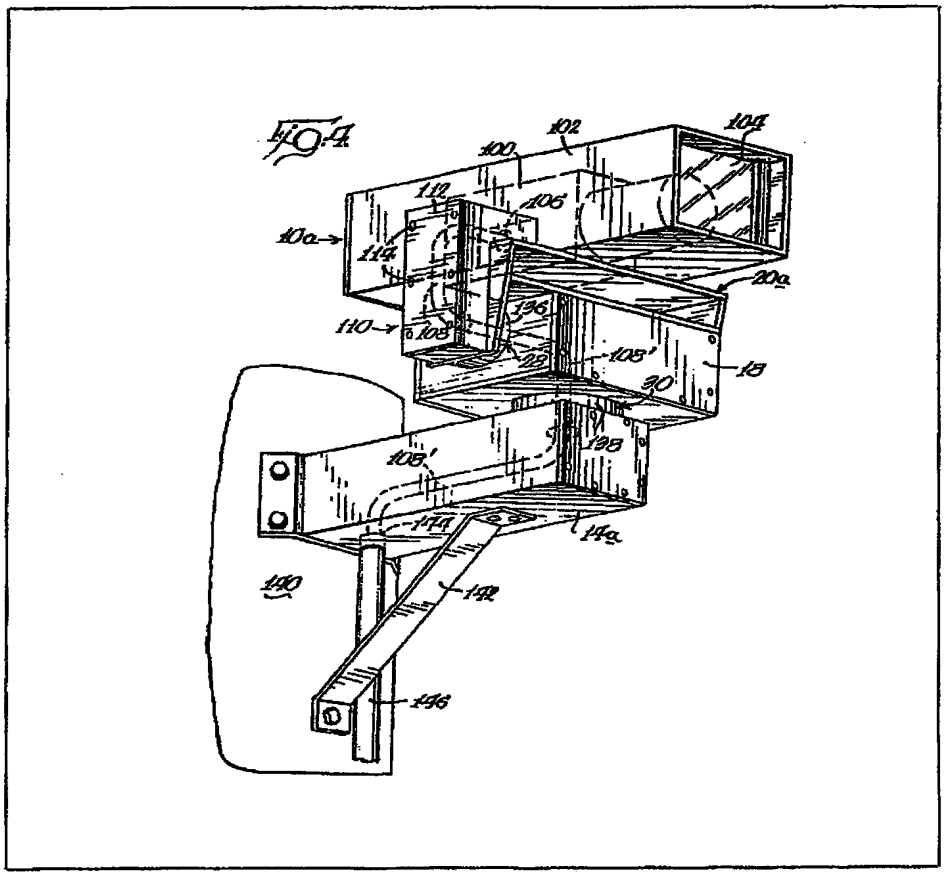

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Fig. 1.

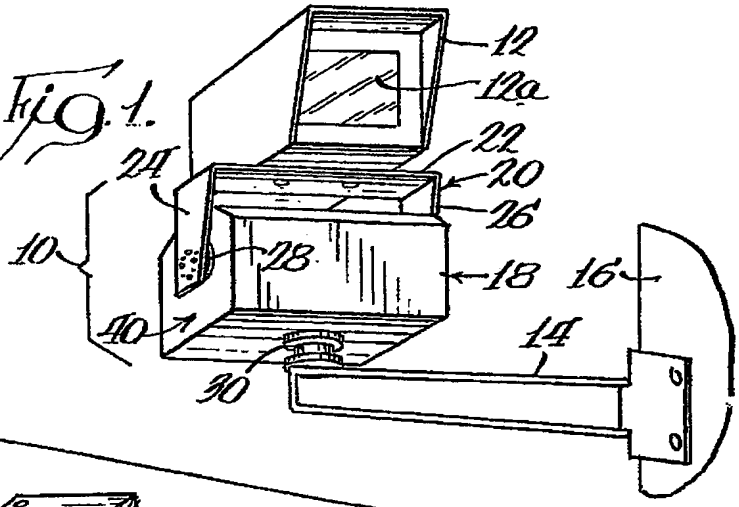


Fig. 2.

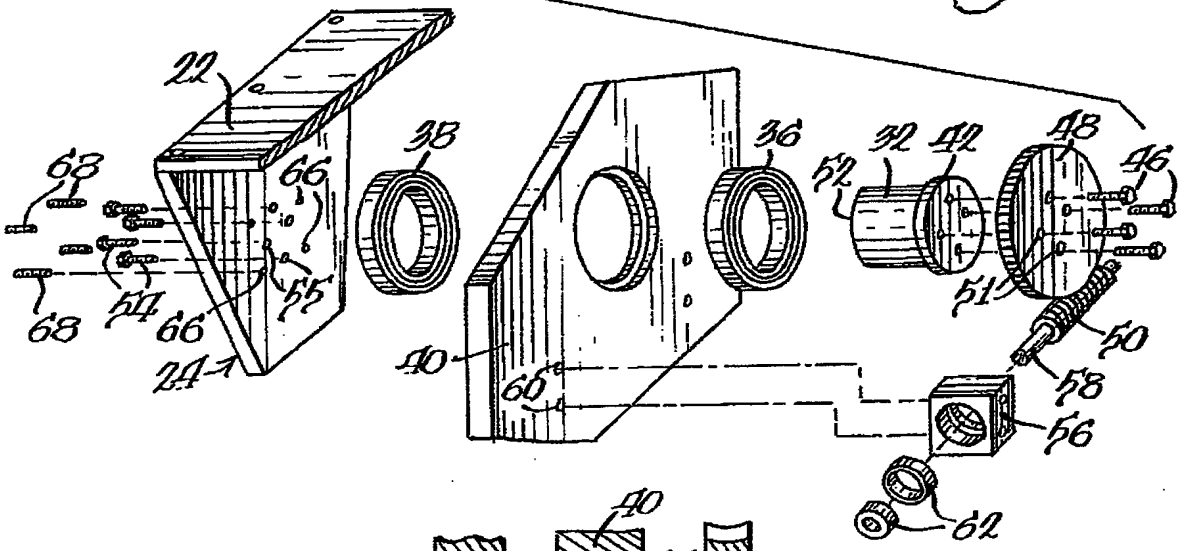


Fig. 3.

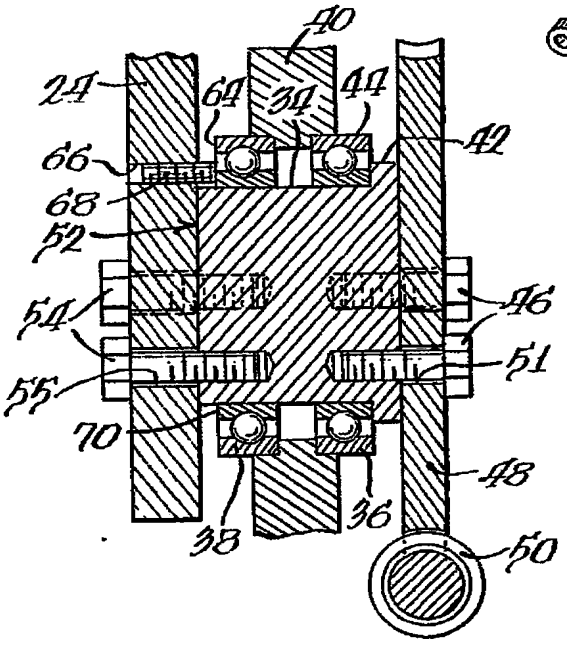


Fig. 4.

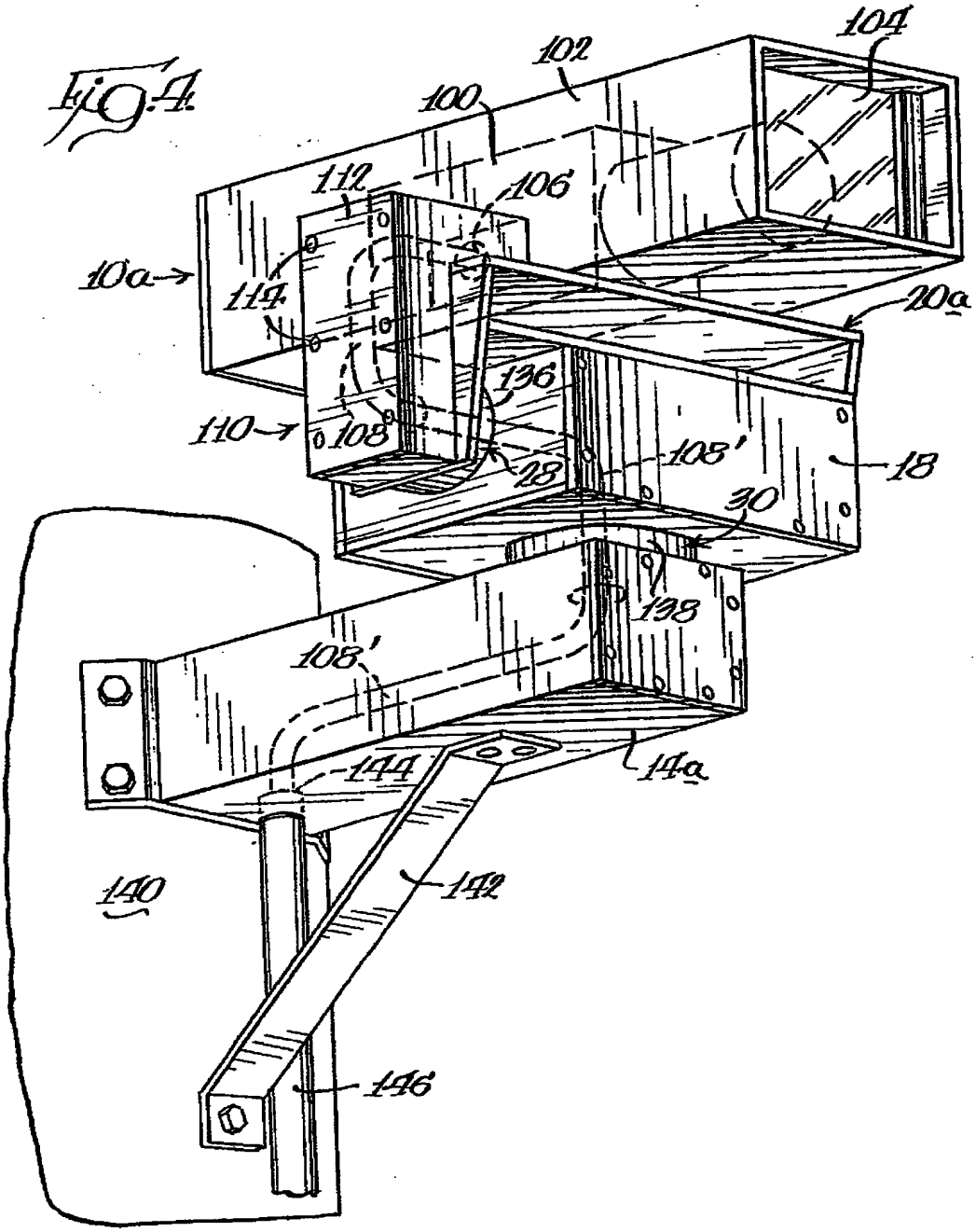

104
102
100
112
106
10a
114
20a
136
110
108
108'
18
28
30
138
108'
144
14a
140
142
146

Fig.5.

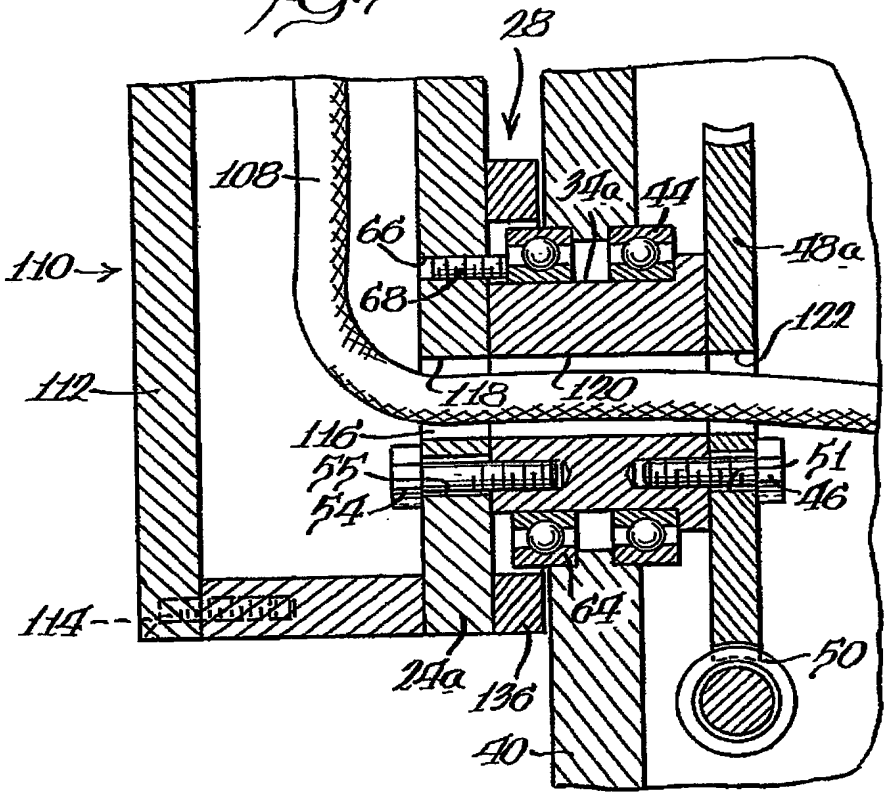
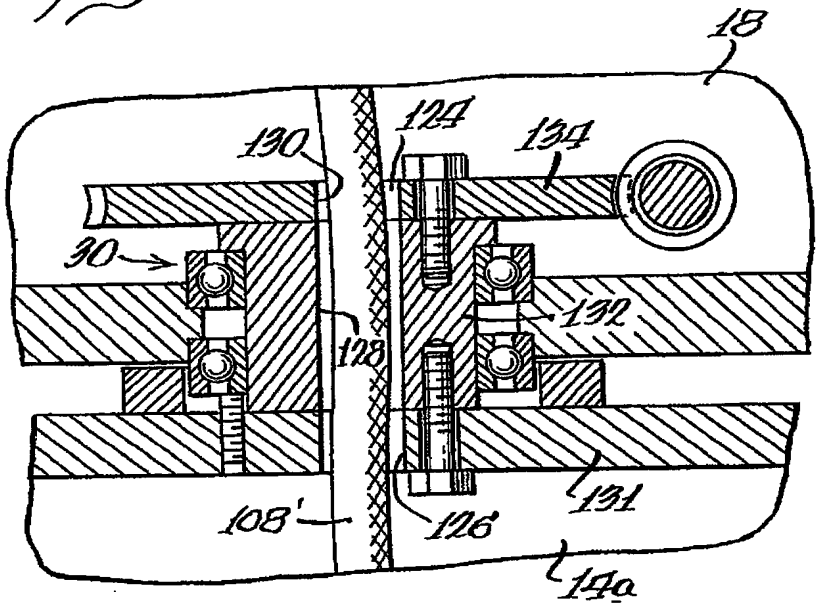

28
108
34a
44
66
48a
110
68
122
112
118
120
116
55
51
54
46
64
114
50
24a
136
40

Fig.6.


18
124
130
134
30
132
128
131
108'
126
14a

SPECIFICATION

Bullet proof pan and tilt camera housing

This invention relates to mounting systems having tilt and swivel capability used in connection with equipment which is located in highly vulnerable positions and thus needs to be protected from extreme external forces. In particular, the subject matter of this invention is a mounting system for remotely controlled television surveillance systems or directional antennas such as those used in microwave transmission systems, and is especially suited for application in secured areas such as banks where individuals may take extreme measures, including gunfire, to attempt to incapacitate the equipment.

The demand for high security motorized mounting systems which may be remotely controlled has been increasing as the versatility and sophistication of the associated equipment increases. For example, television surveillance systems are presently used to permit observation of processes taking place in hostile environments, to allow observation of potentially dangerous area without endangering the operator, and to expand the senses of the operator by permitting observation of events taking place at great distances. These systems are presently being used extensively in locations such as retail stores and banks, where the camera equipment itself requires extensive protection to ensure functioning at critical times.

Mounting systems are presently available which permit full 360° rotation, a so-called "panning" operation, and also permit the camera to be raised and lowered a full 180°, a so-called "tilt" operation.

Present systems generally include a rectangular base which contains the motor and drive system. The drive rotates a shaft extending through opposite sides of the base. Attached to the ends of the shaft are the depending legs of an inverted U-shaped frame upon which is mounted the device to be directionally positioned. Rotation of the shaft thus causes the camera to tilt. A similar arrangement connects the base to a support and allows the system to swivel or pan. The shafts are generally of a small diameter, seldom as much as 2.54 cm. (one inch), and are attached to the drive gears by means of a key and set screw arrangement.

Present systems also generally have a variety of wires and cables extending to a remote site. For example, there are cables for supplying power to the mounting and equipment, cables for controlling movement of the mounting, and equipment cables such as the television coaxial cable. These cables have been exposed outside the protection of the mounting and thus have been susceptible to damage. Because the mounting pans and tilts, however it has not been possible to protect all the cables in a rigid covering. And, while flexible shields are available to protect the cables as they extend from the mounting, these shields can be very expensive depending on the degree of protection required.

Considering these drawbacks in existing systems, I have developed a mounting system which consolidates the cables together and retains that single cable inside the moving components, permitting the cable to exit from the system at a fixed point so as to eliminate the need for expensive flexible shields.

In one aspect of the invention, the mounting consists of a fixed support, a base, and a U-shaped housing support frame where the base may pivot around a vertical axis extending through the fixed support and the housing support frame may pivot about a horizontal axis extending through the base. The pivotal connections between the components are basically identical, each consisting of an oversized tubular support shaft journaled in the base and connected at its exterior end to either fixed support or the housing support frame. A drive mechanism within the base is externally controlled to move the mounting to be positioned in any desired direction. The housing supprt frame encloses equipment such as a TV camera and the housing extends down one arm of the U-shaped frame. The various cables for the equipment pass from the housing through the base and two tubular support shafts defining the two pivot axes to the fixed support. The mounting power supply and control cables are grouped with the equipment cables in the base so that they extend from the base to the support through the second of the tubular support shafts. The cables may be inexpensively guarded as they exit from a fixed point on the fixed support.

While the primary object of this invention is to protect a cable within a pivoting mounting, avoiding the need for an expensive flexible cover for protection, it will be apparent that the above-described arrangement results in other desirable features. For example, use of the oversized tubular shaft decreases component wear and thereby increases the useful life of the mounting system. Further, this invention may use the backlash-free driving mechanism which is described herein and is the subject of U.S. Serial No. 93,797, which is a co-pending application upon which this application is based in part.

Other objects, aspects and features of this invention will become apparent through close inspection of the drawings, specification and the appended claims.

Figure 1 is a perspective view of one aspect of the mounting system used in conjunction with a surveillance camera, this system illustrating the operating characterisrics of the mounting arrangement but not including the features for protecting the cable;

Figure 2 is an exploded view of the gearing and supporting shaft arrangement of the embodiment shown in Fig. 1;

Figure 3 is a partial vertical section depicting the relationship between the drive gear, base side wall and frame leg for the embodiment shown in Fig. 1;

Figure 4 is a perspective view of the mounting system containing the features for protecting the cable and showing in phantom the arrangement of the cable within the system;

Figure 5 is a partial vertical section of the embodiment shown in Fig. 4 depicting the relationship between the drive gear, base side wall and frame leg and showing the cable as it passes therethrough; and

Figure 6 is a partial vertical section similar to Fig. 5 depicting the relationship between the drive gear, base bottom and fixed support.

Referring to the drawings, and particularly Fig. 1, a motorized, remotely controlled mounting unit, generally indicated by the numeral 10, is shown supporting a television surveillance camera enclosure 12 aimed to view through a transparent front window 12a. This unit discloses the inventive system which is the subject of the copending application, which system is also uniquely adaptable to provide the security and operational protection required in certain applications. Such an adapted unit is shown in Figs. 4–6 and discussed in detail further below.

The mounting unit shown in Fig. 1 is supported by a stationary support 14 shown attached to the corner of a building 16. Although the mounting unit 10 is shown used in conjunction with a television surveillance camera, it is apparent that any device in which directional control would be necessary or useful, and which could be adapted to the mounting unit 10, could be substituted for the television camera. Further, the stationary support 14 and building 16 are shown for illustrative purposes only, and it should be recognized that any supporting structure, such as a tower or pole, could be substituted. As detailed further below, a stationary support different from that shown in Fig. 1 is preferred in the embodiment providing protection to the television cable.

The mounting unit 10 consists of a base unit is and a mounting frame 20. The base 18 must be large enough to contain drive motors (not shown) which will cause the unit 10 to pan and/or tilt in response to command signals originating to a remote location. These signals are directed to the unit 10 by conventional means, for example, by a cable.

The mounting frame 20 is formed in the shape of an inverted U and consists of an equipment support table 22 and depending legs 24, 26. As will be more fully explained below, if the equipment to be supported is relatively light, one of the depending legs 24,26 may be eliminated and the equipment supported in cantilever fashion. The frame member 20 may be formed from a continuous piece of material or may be manufactured by welding or fastening separate pieces to each other.

Located between the base unit 18 and one or both depending legs 24,26 is a shaft and bearing assembly 28 which allows the camera housing to be lowered or elevated ("tilted") 90° from the horizontal in either direction. A similar shaft and bearing assembly 30 connects the base unit 18 and the support 14 to permit the entire mounting unit 10 and the attached housing 12 to be rotated ("panned") a full 360° or any lesser arc which may be desired.

Construction of the shaft and bearing assemblies 28,30 is illustrated in Figs. 2 and 3 which depict the assembly in exploded and sectional views, respectively.

A large diameter support shaft 32 consists of an elongated cylindrical section 34 which is journaled in dual bearings 36 and 38 and extends from the interior of the base unit 18 through a base side wall 40. The support shaft 32 also includes a cylindrical shoulder section 42 the diameter of which is greater than the diameter of the cylindrical section 34 of the shaft 32 but less than the inner diameter of the outer bearing race 44.

The cylindrical shoulder section 42 is attached by multiple bolts 46 to a gear 48 which is the output gear of a worm 50 and gear combination.

The diameters of the shaft 32, shoulder 42 and gear 48 are not critical except that the diameters must be large enough to accommodate a number of bolts 46 adequate to prevent relative motion between the shaft 32 and the gear 48 through friction alone. The use of bolts will permit easy disassembly and allows clearance holes 51 to be formed in the gear 48, permitting standard manufacturing methods to be used.

The width of the shoulder 42 is not also critical; however, as best seen in Fig. 3, the width of the shoulder 42 largely determines the spacing between the gear 48 and the base side wall 40 and thus also the spacing between the longitudinal axis of the worm 50 and the side wall 40. It is desirable to keep the worm 50 and the gear 48 as close to the side wall 40 in order to provide increased free space within the base 18 for the motors and controls, but it is necessary that the spacing be such that clearance is provided between the side wall 40 and any drive members (sprockets, gears, belt pulleys) which may be attached to the worm 50. It is sufficient to recognize that the spacing distance may be varied by altering the height of the shoulder 42.

While the shaft 32 and the gear 48 may be formed from a single piece of stock material, the single piece must still retain the shoulder

42 to provide the above-mentioned spacing and a surface which bears against the bearing.

The end 52 of the shaft 32 opposite the cylindrical shoulder 42 is likewise attached to the depending frame leg 24 by multiple bolts 54. As indicated above, the bolts allow easy disassembly and clearance holes 55 to be used in the leg 24. The number and size of bolts 54 to be used depends upon the frictional force which must be generated between the leg 24 and the shaft 32 ro preclude relative motion under all operation conditions.

Since both the leg 24 and the gear 48 are rigidly attached to the shaft 32, any rotational free play or "backlash" which would result in undesirable tilting of the camera 12 can only come from either longitudinal motion of the worm 50 or gear tooth backlash between the worm 50 and the gear 48. Manufacturing convenience and cost reduction may be aided by utilizing four machine screws to fasten the leg 24, shaft 32 and gear 48 together, such screws passing through the leg 24 and shaft 32 and into threaded openings 51 in the gear.

To eliminate these possible sources of unwanted rotational motion, the worm 50 is provided on either end with adjustment blocks 56 (only one of which is shown) which are attached by bolts (not shown) to the side plate 40 and which may be adjusted toward or away from the center of the gear 48 to eliminate gear tooth backlash. Adjustment of the blocks 56 may be accomplished by providing clearance holes 60 or slots in the side wall 40. Longitudinal motion of the worm 50 is adjusted with an adjustment nut (not shown) applied to the shaft of the worm and bearing upon one of the blocks 56. Tightening of the attachment bolts in the adjustment blocks 56 will then retain the blocks 56 in proper alignment.

While it is preferred that worm-type gearing be used so backlash may easily be eliminated by the conventional means outlined above, other well-known power transmission systems could by used to impart rotation to the shaft 32 provided backlash may be eliminated from the power train utilized.

Since the frame leg 24 is rigidly attached to the gear 48 by the shaft 32 and free play has been eliminated in the worm 50 and between the worm 50 and the gear 48, the support frame 20 cannot rotate relative to the base 18 unless the worm 50 is rotated by the motor.

As shown most clearly in Fig. 3, the cylindrical section 34 of the support shaft 32 is formed to a length slightly greater than the overall width of the bearing combination 36,38. The particular distance between the outer edge 64 of the bearing 38 and the end 52 of the shaft 32 is not critical and permits the shaft 32 to be economically manufactured since close tolerances need not be maintained.

Because of the gap produced between the bearing 38 and the leg 24 by the excess length of the shaft 32, axial motion of the support shaft 32 might be possible which would in turn cause transverse motion of the camera 12. To prevent such axial motion, the leg 24 is provided with multiple threaded holes 66 which receive threaded set screws 68. The side plate holes 66 are positioned around the circumference of the shaft 32 such that their associated set screws 68 will bear upon only the inner race 70 of the outer bearing 38. Tightening of the set screws 68 will force the side plate away from the bearing 38, drawing the shaft 32 towards the left, as viewed in Fig. 3, until the shoulder 42 contacts the inner bearing 36.

When the set screws 68 are properly adjusted, the bearing combination 36,38 will be im compression between the shoulder 42 and the set screws 68, thereby eliminating relative motion between the shaft 32 and bearings 38,38 which would otherwise be present due to the length of the shaft 32.

Dual bearings 36,38 are shown supporting the shaft 32 in order to provide a wide and stable base for the shaft 32. Because of this wide supporting area, the shaft 32 and bearing 36,38 arrangement may be used singly in cantilever fashion wherein a depending leg 26 is eliminated and the support frame only consists of one depending leg 24 and the horizontal support table 22. Alternatively, if the weight of the equipment to be supported demands, the other depending leg 26 may be included and connected to the base 18 by means of a conventional bearing arrangement. Since all rotational and axial free movement is precluded by the single shaft 32 and bearing 36,38 assembly, this assembly need not be duplicated on the remaining depending leg 26.

It will be recognized that if a cantilever arrangement were not or could not be used, dual bearings 36,38 need not be provided since a wide support base would not be necessary. The dual bearings 36,38 could be replaced by a single bearing without changing the relationship or beneficial functions of the parts heretofore described. A wide variety of bearing sizes and types, such as double row ball, tapered roller, or angular contact ball bearings, could be utilized without departing from the spirit of this invention.

While the specific arrangement illustated utilizes the shaft 32 with its shoulder 42 between the bearing 36 and gear 48, a reversal of the shaft may be made to place the shoulder 42 between the leg 24 and inner race 70 of outer bearing 64. In the latter position, set screws 68 would be threaded into the gear 48 to engaged the inner race of bearing 36, to perform in the same fashion as described. Threaded holes would be provided

in the gear 48 similar to the holes 66 illustrated as present in the leg 24. It may also be desirable to substitute a spring for the set screws, such as a wavy washer configuration which will exert force upon one inner race as the leg 24, shaft 32 and gear 48 are tightened together. Use of such a spring would tend to eliminate personal judgement relative to the amount of tightening of the set screws desirable.

Thus far, a system has been described which would eliminate unwanted relative motion between the base 18 and the support frame 20. Also present in the mounting system, however, is movement between the base 18 and the fixed structural support 14. The base 18 must be allowed to rotate relative to the support 14 without allowing any unwanted motion to be transmitted to the camera enclosure 12. A shaft 32 and bearing 36,38 assembly is thus provided between the base 18 and the support 14 which contains parts which are structured and cooperate identically to the assembly positioned between the base 18 and the frame 20. In the same manner as described above, relative rotational or axial movement between the base 18 and support 14 is precluded.

Since all unwanted free play is eliminated at every system pivot point, no motion of the camera enclosure 12 relative to the support 14 can occur. The system thus described allows panning and tilting the camera enclosure 12 without permitting the camera to jiggle or lose focus due to shock or variable winds after being positioned.

With a knowledge of the operation of this pan and tilt system, the modifications necessary to protect the camera cable as shown in Figs. 4–6 can be easily understood. As will be seen in the detailed description below, only three features need to be added to the basic structure described above: a L-shaped enclosure on the equipment support table 22, a fixed support which also defines an enclosure, and holes defined tbrough each bearing assembly 28,30 to connect the added enclosures with the base 18. This enables the camera cable to be threaded within the moving components of a protective housing to a fixed opening in the fixed support 14a. The cable thus need not be given flexibility outside the protective housing and simple and inexpensive means, such as a pipe, may be used to protect the cable outside the housing.

Referring to the drawings and particularly Fig. 4, a motorized, remotely controlled mounting unit 10a, similar to the embodiment disclosed in Figs. 1–3, is shown supporting a television surveillance camera 100 in a bulletproof (resistant) enclosure 102. The camera 100 is aimed to view through a transparent front window 104 which is also bulletproof, typically of a tempered glass 5.08 cm thick (two inches). The camera enclosure 102 has an opening 106 on one side which permits a cable 108 to pass through. This cable 108 has the coaxial cable of the camera as well as a cable which supplies power to the camera. The opening 106 connects the camera enclosure 102 with another enclosure defined by an L-shaped housing 110 fixably mounted onto the mounting frame 20a by welding or other means. The side wall 112 of the L-shaped housing 110 is secured to the remainder of the L-shaped housing 110 by means of screws 114, permitting access to the cable 108 without endangering it since protection is required primarily against quick violent forces. For example, a felon in a bank lobby would be highly unlikely to spend the time necessary to remove the plate in order to gain access to the cable 108.

The cable 108 extends from the L-shaped housing 110 into the base 18 by passing through a cable passageway 116 defined through the bearing 28 as shown in Fig. 5. The passageway is defined by holes 118, 120,122 through the frame depending leg 24a, the elongated circular section 34a (making the section tubular) and the attached gear 48a, each hole 118, 120, 122, being of equal cross-sectional size and centred on the horizontal axis of rotation so as to define a smooth passageway 116. In all other respects, this bearing 28 is identical to that shown in Figs. 2 and 3.

The cable 108 extends into the base 18 and is there consolidated with cables which terminated in the base 18 (i.e., power supply and control cables for the mounting). This consolidated cable 108′ extends to the vertically aligned bearing 30 where it passes through a similar passageway 124 in the bearing 30 as shown in Fig. 6. This passageway 124 is defined by holes 126, 128,130 in the upper wall 131 of the fixed support 14a, the elongated circular section 132 (making it tubular), and the attached gear 134, respectively, each of these holes 126,128,130 being of equal cross-sectional size and centered on the vertical axis of rotation, thereby also defining a smooth passageway 124. The cable passageway 124 is centered so that movement of the parts causes no corresponding direct movement of the cable 108′. In all other respects, this bearing 30 is also identical to the corresponding vertical bearing 30 described for the embodiment shown in Figs. 1–3.

Unlike the shafts used for pan and tilt motion with previous mountings, the elongated circular sections 34a,132 in this system have a large outer diameter. This larger size enables the elongated sections 34a,132 to have passageways 116,124 extending therethrough without weakening the sections' load-carrying capabilities or inducing backlash. Both bearings 28,30 also include protective rings 136,138 on the frame depending leg

26 and fixed support 14a, respectively. These rings 136,138 project far enough to protect the bearing assemblies against fired bullets interfering with the operative character of the bearing assemblies but not so far as to interfere with the fitting of the cyindrical shoulder section 42 against the inner race of the bearing 36.

The fixed support 14a in this embodiment defines an enclosure which protects the cable 108'. The fixed support 14a shown in Fig. 4 is attached to a post 140 and has a brace 142 for added support. This support 14a has an opening 144 in its bottom surface which is connected with a rigid pipe 146 through which the cable 108' is threaded. This pipe 146 shields the cable 108' is a protective covering and extends to a location which is secure from possible assault, for example, behind a wall.

By making all the components of a material, such as steel, which is thick enough to resist deformation or penetration from most portable guns and weapons, the camera 100, cable 108, and drive mechanism are secured from damage resulting from external forces.

This configuration still permits free pan and tilt movement because the cable 108 passes between the pivoting components through holes 116,118 at the axes of the pivotal movement. The cable 108 is given some slack throughout the system to permit the twisting which occurs on the cable during the pivotal movement to be spread out over a longer length. The stresses applied by such twisting are well within the tolerable limits for this type of cable.

CLAIMS

1. An improved pan and tilt mounting for a TV camera or the like which mounting encloses the camera and its cables in a bulletproof enclosure, comprising:

fixed support means defining an enclosure;

a base having top and bottom surfaces, front and back walls, and side walls and rotatable about a vertical axis through said fixed support means;

a support frame rotatable about a horizontal axis through said base;

a housing on said support frame enclosing the camera and extending to said horizontal axis;

a first shaft rotatable about said horizontal axis including a tubular portion journaled through a first bearing rigidly mounted to one of said side walls, said shaft having an end of said tubular portion rigidly attached to said support frame;

a second shaft rotatable about said vertical axis including a tubular portion journaled through a second bearing rigidly mounted to said bottom surface, an end of said shaft being rigidly mounted to said fixed support means;

drive means contained within said base connected to each of said first and second shafts;

whereby a camera cable may extend from said housing through said first shaft, said base and said second shaft into said fixed support means.

2. The improved pan and tilt mounting of claim 1, further comprising protective rings on said support frame and said fixed support means substantially enclosing the portions of said shafts extending outside said side and base walls.

3. The improved pan and tilt mounting of claim 1, wherein the outer surfaces of said base, fixed support means, support frame, and housing are provided with bulletproof enclosing walls enclosing space in which camera cables and the like may repose.

4. The improved pan and tilt mounting of claim 1, further comprising a rigid enclosure means for the cable extending from said fixed support means to a position remote from the mounting location.

5. An improved pan and tilt mounting for a TV camera or the like, which mounting encloses a camera and its cable in a bulletproof enclosure, comprising:

fixed support means defining an enclosure;

a base having top and bottom surfaces, front and back walls, and side walls rotatable about a vertical axis through said fixed support means;

a support frame rotatable about a horizontal axis through said base;

a housing on said support frame enclosing the camera and extending to said horizontal axis;

a first bearing assembly attached to said side wall and located in a bore formed in said side wall;

a second bearing assembly attached to said bottom surface and located in a bore formed in said bottom surface;

a first shaft journaled in said first bearing assembly;

second shaft journaled in said second bearing assembly;

each of said first a second shafts having a central cable passageway threrthrough centered upon the center of rotation of such shaft;

housing materials respectively enclosing said first bearing assembly and said second bearing assembly from exposure to surrounding areas and opening each assembly to the interior of said camera housing and base respectively so that camera and control cable may be threaded from outside through said base and into the camera housing without ambient exposure.

6. The improved pan and tilt mounting of claim 5, wherein said housing, said base, and said fixed support means are all made of bulletproof material.

7. The improved pan and tilt mounting of claim 5, further comprising a rigid bulletproof covering on the camera cable protecting the cable between the point at which it leaves the mounting from said fixed support means and a point remote from said mounting location.

8. The improved pan and tilt mounting of claim 5, wherein the cable contains slack in the path through which it is threaded, thereby reducing cable interference with tilt and rotation.

9. The improved pan and tilt mounting of claim 5, wherein said shafts are large enough in cross section so that said cable passageways loosely receive the cable to permit pan and tilt without binding of the cable.

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